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(54) VALVE TIMING ADJUSTING DEVICE FOR INTERNAL COMBUSTION ENGINE

(57) [Claim(s)]

[Claim 1] It is prepared in the driving force transfer system which transmits driving force to the follower shaft of an internal combustion engine's inlet valve and an exhaust valve which opens and closes either at least from an internal combustion engine's driving shaft. The housing member rotated with either said driving shaft or said follower shaft, the hold room which rotated with another side of said driving shaft or said follower shaft, and was formed in said housing member — the predetermined include-angle range — restricting — said housing member — receiving — relativity — with the vane member held rotatable The contact section and the contacted section which are prepared in said housing member and said vane member, respectively, contact mutually, and restrain the rotation directional movement of said housing member and said vane member in a predetermined restricted location are included. A restricted means including an energization means to be constituted by the variation rate of said contact section possible [discharge of a restricted condition],

and to energize said contact section in the contact direction to said contacted section further, While resisting and carrying out the variation rate of said contact section to said energization means with fluid pressure and canceling constraint with said housing member and said vane member It has the driving means of the fluid-drive type which carries out relative rotation of said housing member and said vane member with fluid pressure. Said contact section It is constituted so that constraint with said housing member and said vane member may be canceled in response to the fluid pressure supplied from said driving means. The 1st fluid pressure supplied from said driving means so that the relative rotation of said vane member may be made to carry out in the direction of a tooth lead angle to said housing member acts, and said restricted condition is canceled. The valve timing adjusting device for internal combustion engines characterized by being constituted so that the 2nd fluid pressure supplied from said driving means so that the relative rotation of said vane member may be made to carry out in the direction of a lag to said housing member may act and said restricted condition may be canceled.

[Claim 2] It is prepared in the driving force transfer system which transmits driving force to the follower shaft of an internal combustion engine's inlet valve and an exhaust valve which opens and closes either at least from an internal combustion engine's driving shaft. The housing member rotated with either said driving shaft or said follower shaft, the hold room which rotated with another side of said driving shaft or said follower shaft, and was formed in said housing member -- the predetermined include-angle range -- restricting -- said housing member -- receiving -- relativity -- with the vane member held rotatable The contact section and the contacted section which are prepared in said housing member and said vane member, respectively, contact mutually, and restrain the rotation directional movement of said housing member and said vane member in a predetermined restricted location are included. A restricted means including an energization means to be constituted by the variation rate of said contact section possible [discharge of a restricted condition], and to energize said contact section in the contact direction to said contacted section further, While resisting and carrying out the variation rate of said contact section to said energization means with fluid pressure and canceling constraint with said housing member and said vane member It has the driving means of the fluid-drive type which carries out relative rotation of said housing member and said vane member with fluid pressure. Said contact section It has the 1st and 2nd pressure receiving side which cancels constraint with said housing member and said vane member in response to the fluid pressure supplied from said driving means. The 1st fluid pressure supplied to said 1st pressure receiving side from said driving means so that the relative

rotation of said vane member may be made to carry out in the direction of a tooth lead angle to said housing member acts. The valve timing adjusting device for internal combustion engines characterized by being constituted so that the 2nd fluid pressure supplied to said 2nd pressure receiving side from said driving means so that the relative rotation of said vane member may be made to carry out in the direction of a lag to said housing member may act and said restricted condition may be canceled.

[Claim 3] The valve timing adjusting device for internal combustion engines according to claim 1 or 2 characterized by forming the fluid damper which eases the displacement rate of said contact section with an internal working fluid between said contact section and said contacted section.

[Claim 4] They are claim 1 which said contact section has the back pressure room which the volume reduces in connection with the variation rate to the restricted discharge direction of said contact section, and is characterized by said contact section blockading a free passage hole with the exterior of said back pressure room in a restricted discharge condition thru/or the valve timing adjusting device for internal combustion engines of three given [any / one] in a term.

[Claim 5] Said contact section and said contacted section are claim 1 characterized by being constituted so that it may contact, when said follower shaft is in the maximum lag condition by which the lag was carried out most thru/or the valve timing adjusting device for internal combustion engines of any one publication of four.

[Claim 6] It is the valve-timing adjusting device for internal combustion engines which has the contact section and the contacted section which restrains the rotation directional movement of a housing member and a vane member in a predetermined restricted location in the vane-type valve-timing adjusting device for internal combustion engines, and is characterized by to turn the contact section to the condition do not restrain, and to be driven and held by both the 1st fluid pressure which changes valve timing to a tooth-lead-angle side, and the 2nd fluid pressure which changes valve timing to a lag side.

[Claim 7] It is the valve-timing adjusting device for internal combustion engines which has the contact section and the contacted section which restrain the rotation directional movement of a housing member and a vane member in a predetermined restricted location in the vane-type valve-timing adjusting device for internal combustion engines, and is characterized by for the contact section to always hold the contact section in the condition do not restrain when either of the 1st fluid pressure which changes valve timing to a tooth-lead-angle side, and the 2nd fluid pressure which changes valve timing to a lag side is supplied.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the valve timing adjusting device for [of an internal combustion engine's (an "internal combustion engine" is hereafter called engine) inlet valve, and an exhaust valve] changing one of closing motion timing according to a service condition at least.

[0002]

[Description of the Prior Art] Conventionally, a cam shaft is driven through the timing pulley and chain sprocket which carry out synchronous rotation with an engine crankshaft, and what is indicated by JP,1-92504,A as a vane-type valve timing adjusting device of an inlet valve and an exhaust valve which opens and closes either at least according to the phase contrast by relative rotation with a timing pulley, a chain sprocket, and a cam shaft is known.

[0003] In what is indicated by JP,1-92504,A, the dowel pin is held in the both sides of the direction of a path of a timing pulley, respectively. rotation Rota -- a cam shaft and a vane -- rotating -- and a timing pulley and relativity -- it is rotatable. When a vane rotates in the direction of a lag, or the direction of a tooth lead angle to a timing pulley, the hole into which either of two dowel pins can fit is established in rotation Rota.

[0004] For this reason, if rotation Rota rotates in the direction of a lag, or the direction of a tooth lead angle to a timing pulley with a vane, when a dowel pin fits into the hole of rotation Rota, both a timing pulley and rotation Rota will rotate. Moreover, when changing the phase of rotation Rota to a timing pulley from the condition to which the dowel pin fitted into the hole, after ejection and rotation Rota rotate [a dowel pin] from one hole by switching oil pressure, when a dowel pin fits into the hole of another side, both a timing pulley and rotation Rota rotate again.

[0005] Since tie imine GUPURI and rotation Rota are connected with the dowel pin by this even if a cam shaft produces forward and negative torque to a timing pulley with the drive of an inlet valve or an exhaust valve, tap tone generating with a vane and a timing pulley can be prevented.

[0006]

[Problem(s) to be Solved by the Invention] However, in what is indicated by JP,1-92504,A, since a dowel pin fits into the hole of ejection another side from one hole of rotation Rota whenever rotation Rota rotates in the direction of a tooth lead angle, or the direction of a lag to a timing pulley, while becoming easy to wear a dowel pin and a hole out, if a dowel pin and a hole are not processed with high precision, a dowel pin cannot fit into a hole or a tap tone may occur at the time of fitting.

[0007] Moreover, in order that a dowel pin may operate to radial [of rotation Rota], there is a problem that there is a possibility that a centrifugal force may affect actuation of a dowel pin.

[0008] It is made in order that this invention may solve such a problem, and when the fluid of a predetermined pressure is not supplied from a driving means, it aims at offering the valve timing adjusting device for engines which restrains a housing member and a vane member and prevents tap tone generating with a housing member and a vane member.

[0009]

[Means for Solving the Problem] According to the valve timing adjusting device for engines of this invention according to claim 1, the contact section is turned to the condition of not restraining, and is driven and held by both the 1st fluid pressure which changes valve timing to a tooth-lead-angle side, and the 2nd fluid pressure which changes valve timing to a lag side.

[0010] For this reason, since the contact section can always be held in the condition of not restraining when the fluid pressure from a driving means to either is supplied, the count of actuation of the contact section can be reduced and endurance can be improved.

[0011] In the valve timing adjusting device for engines of this invention according to claim 2 The contact section has the 1st and 2nd pressure receiving side which cancels constraint with a housing member and a vane member in response to the fluid pressure supplied from a driving means. The 1st fluid pressure supplied to the 1st pressure receiving side from a driving means so that the relative rotation of the vane member may be made to carry out in the direction of a tooth lead angle to a housing member acts. He is trying for the 2nd fluid pressure supplied to the 2nd pressure receiving side from a driving means so that the relative rotation of the vane member may be made to carry out in the direction of a lag to a housing member to act. Thus, you may make it receive the 1st and 2nd fluid pressure by each of the 1st and 2nd pressure receiving side.

[0012] By forming the fluid bumper which eases the displacement rate of the contact section between the contact section and the contacted section according to the valve timing adjusting device for engines of this invention according to claim 3 In the transition stage when it is in the location which can displace the contact section in the direction which restrains a housing member and a vane member in, and fluid pressure switches from a restricted discharge condition to another restricted discharge condition, when the fluid pressure which acts on the contact section declines for a moment, it can prevent that the contact section displaces in the

restricted direction for a moment.

[0013] Since according to the valve timing adjusting device for engines of this invention according to claim 4 atmospheric air cannot be introduced into a back pressure room from a free passage hole even if the contact section tends to displace in the restricted direction in a restricted discharge condition, when the contact section blockades a free passage hole with the exterior of a back pressure room, the displacement rate to the restricted direction of the contact section is eased.

[0014] In the transition stage when it is in the location which can displace the contact section by this in the direction which restrains a housing member and a vane member in, and fluid pressure switches from a restricted discharge condition to another restricted discharge condition, when the fluid pressure which acts on the contact section declines for a moment, it can prevent that the contact section displaces in the restricted direction for a moment.

[0015] According to the valve timing adjusting device for engines of this invention according to claim 5, it contacts mutually [the contact section and the contacted section / when a follower shaft is in the maximum lag condition by which the lag was carried out most], and a housing member and the vane member of each other are restrained.

[0016] In the maximum lag location excellent in engine startability, a housing member and a vane member are restrained by this, and in the condition that the fluid pressure supplied by the driving means like [at the time of engine starting] is not fully increasing, tap tone generating of a valve timing adjusting device can be prevented, securing engine startability.

[0017] In addition, the constraint in the maximum lag condition can be attained by restraining a housing member and a vane member, when a vane member rotates with a follower shaft and a vane member is in the location by the side of the maximum lag to a housing member. On the other hand, when a vane member rotates with a driving shaft and a vane member is in the location by the side of the maximum tooth lead angle to a housing member, it is attained by restraining a housing member and a vane member.

[0018]

[Embodiment of the Invention] Hereafter, two or more operation gestalten which show the gestalt of operation of this invention are explained based on a drawing.

(The 1st operation gestalt) The valve timing adjusting device for engines by the 1st operation gestalt of this invention is shown in drawing 1 – drawing 8 . Drawing 8 shows the hydraulic circuit of the 1st operation gestalt.

[0019] Driving force is transmitted to the chain sprocket 1 shown in drawing 1 from

the crankshaft as a driving shaft of the engine which is not illustrated with the chain which is not illustrated, and it is rotated synchronizing with a crankshaft.

[0020] Driving force is transmitted to the cam shaft 2 as a follower shaft from the chain sprocket 1, and if there are few inlet valves which are not illustrated and exhaust valves, it will carry out the closing motion drive of one side. The cam shaft 2 sets predetermined phase contrast to the chain sprocket 1 and is rotatable. The chain sprocket 1 and a cam shaft 2 are clockwise rotated seen from the direction of arrow-head X shown in drawing 1 . This hand of cut is made into the direction of a tooth lead angle below.

[0021] As shown in drawing 1 and drawing 2 , the chain sprocket 1 and the shoe housing 3 which are a housing member, and a front plate 4 are being fixed on the same axle with the bolt 14. the inner circle wall of boss section 1a of the chain sprocket 1 -- point 2a of a cam shaft 2 -- relativity -- it has fitted in rotatable. With the dowel pin 26, as for a front plate 4 and the shoe housing 3, positioning of the angle-of-rotation direction is made by the dowel pin 27, respectively, as for the shoe housing 3 and the chain sprocket 1.

[0022] As shown in drawing 2 , the shoe housing 3 has the shoes 3a and 3b of the trapezoidal shape which counters mutually. Each opposed face of Shoes 3a and 3b is formed in the shape of cross-section radii, and the flabellate form space section which is the hold room of Vanes 9a and 9b, respectively is formed in two gaps of the hoop direction of Shoes 3a and 3b.

[0023] As shown in drawing 1 and drawing 2 , the vane rotor 9 as a vane member has the sector-like vanes 9a and 9b to the both ends of the direction of a path, and is held in the flabellate form space circles by which these vanes 9a and 9b are formed in the gap of the hoop direction of Shoes 3a and 3b rotatable. Inlaw section 9c fits into point 2a of a cam shaft 2 at the same axle, and the vane rotor 9 is being fixed to the cam shaft 2 by one with the bolt 15.

[0024] As for the vane rotor 9 and the cam shaft 2, positioning of the angle-of-rotation direction is made with the dowel pin 28. the cylinder lobe 5 fixed to the vane rotor 9 and one -- the inner circle wall of a front plate 4 -- relativity -- it has fitted in rotatable. as shown in drawing 2 , the minute path clearance 16 and 17 prepares between the peripheral wall of the vane rotor 9, and the inner circle wall of the shoe housing 3 -- having -- **** -- the vane rotor 9 -- the shoe housing 3 and relativity -- it is rotatable.

[0025] The lag oil pressure room 10 is formed between shoe 3a and vane 9a, the lag oil pressure room 11 is formed between shoe 3b and vane 9b, the tooth-lead-angle oil pressure room 12 is formed between shoe 3a and vane 9b, and the tooth-lead-angle

oil pressure room 13 is formed between shoe 3b and vane 9a. The die length of the shaft orientations of Vanes 9a and 9b is slightly set up small from the die length of the shaft orientations of the shoe housing 3 pinched between the front plate 4 and the chain sprocket 1.

[0026] the above configuration -- a cam shaft 2 and the vane rotor 9 -- the chain sprocket 1, the shoe housing 3, and a front plate 4 -- receiving -- the same axle -- relativity -- it is rotatable. As shown in drawing 1 , the stopper piston 7 as the contact section is held in the interior of vane 9a of the vane rotor 9. The stopper piston 7 consists of narrow diameter portion 7a and major diameter 7b, and point 7c of narrow diameter portion 7a is slightly formed in the tapering taper configuration as it goes in the anti-major diameter 7b side, i.e., the direction in which the stopper piston 7 fits into the stopper hole 20 as the contacted section.

[0027] Major diameter 7b of the stopper piston 7 is held in the hold hole 8 of vane 9a, and is supported by the wall of vane 9a which forms the hold hole 8 possible [sliding of the shaft orientations of a cam shaft 2]. The spring 18 as an energization means is built into the hold hole 8 on the right-hand side of [which is shown in drawing 1 of the stopper piston 7] shaft orientations. The guide ring 19 is fitted in loosely or pressed fit with the wall of vane 9a which forms the hold hole 8, and has fitted in loosely with the outer wall of narrow diameter portion 7a of the stopper piston 7.

[0028] Therefore, the stopper piston 7 is held in vane 9a possible [sliding of the shaft orientations of a cam shaft 2], and is energized with the spring 18 at the front plate 4 side.

[0029] As shown in drawing 4 , the cone angle of point 7c of the stopper piston 7 and the cone angle of the stopper hole 20 are set up identically, and after the stopper piston 7 has fitted into the stopper hole 20, 7d of apical surfaces of the stopper piston 7 is not in contact with top-face 20b of the stopper hole 20.

[0030] Since the pressure oil is not introduced into the oil pressure rooms 23 and 24 yet when the vane rotor 9 is in the maximum lag location as a restricted location to the shoe housing 3 as shown in drawing 1 and drawing 2 , the stopper piston 7 has fitted into the stopper hole 20 according to the energization force of a spring 18. At this time, stopper section 9e formed in the lag side of vane 9b is in contact with the side face of shoe 3a, and, as for the vane rotor 9, the direct-drive force is received from the shoe housing 3.

[0031] When the shoe housing 3 and the vane rotor 9 are in the maximum lag location, the location of the stopper piston 7 and the location of the stopper hole 20 are designed so that these components of each other may be pushed.

[0032] That is, when stopper section 9e of drawing 2 is in the maximum lag location

adjacent to the side face of shoe 3a, both location is beforehand designed so that eccentricity may be carried out and it may fit into the direction side of a tooth lead angle, as the axial center 100 of the stopper piston 7 shows drawing 4 to the axial center 101 of the stopper hole 20. Since the stopper piston 7 receives stopper hole 20 and works like a wedge by contact to the periphery taper side of the stopper piston 7, and the inner circumference taper side of the stopper hole 20 when the stopper piston 7 fits into the stopper hole 20, the vane rotor 9 and the shoe housing 3 are relatively moved in the rotation direction under the energization force to the shaft orientations of the stopper piston 7.

[0033] With the 1st operation gestalt, taper sides contact the maximum lag side as a restricted location by the direction side of a tooth lead angle of the opposite side like drawing 4 . For this reason, the slant face of a taper side generates the energization force of the rotation direction, in drawing 2 , the vane rotor 9 is energized in the direction of a counterclockwise rotation, and the shoe housing 3 is energized by the shaft-orientations energization force of the stopper piston 7 in the direction of a clockwise rotation. For this reason, the energization force which forces stopper section 9e on the side face of shoe 3a is acquired, and the shoe housing 3 and the vane rotor 9 are restrained firmly.

[0034] In addition, the location of the stopper piston 7 and the location of the stopper hole 20 should be set up so that both may contact on the predetermined side face of the rotation direction of a vane member and may demonstrate the above-mentioned wedge effectiveness also under the error on manufacture. Since the drain hole 21 is formed in the side attachment wall by the side of the chain sprocket 1 of vane 9a which forms the hold hole 8 and the vane rotor 9 of the location of the atmospheric-air hole 22 of the chain sprocket 1 and the drain hole 21 corresponds mostly in the condition of the maximum lag as shown in drawing 1 , the space section by the side of the spring 18 of the stopper piston 7 which are some hold holes 8 is an equivalent for atmospheric pressure.

[0035] As shown in drawing 1 , the oil pressure room 23 is formed between major diameter 7b of a guide ring 19 and the stopper piston 7. The oil pressure room 24 is formed between the stopper hole 20 of a front plate 4, and narrow diameter portion 7a of the stopper piston 7, and the oil pressure room 24 and the tooth-lead-angle oil pressure room 13 are open for free passage with the oil path 25 of a front plate 4.

[0036] As shown in drawing 1 , drawing 2 , and drawing 3 , in the contact section with the cylinder lobe 5, the oilway 30 is formed in the vane rotor 9 in an oilway 29 and the contact section with a cam shaft 2. An oilway 29 is open for free passage with the lag oil pressure rooms 10 and 11 with oilways 31 and 32, and is open for free passage with

the oil pressure room 23 with the oilway 33. The oilway 30 is open for free passage with the tooth-lead-angle oil pressure rooms 12 and 13 with oilways 34 and 35.

[0037] Moreover, the oilway 29 is open for free passage with the oilway 36, and is opening the oilway 36 for free passage with the oilway 39 formed in the cam shaft 2 in the contact section of the shaft orientations of the vane rotor 9 and a cam shaft 2. The oilway 30 is open for free passage with the oilway 38 formed in the cam shaft 2 in the contact section of the shaft orientations of the vane rotor 9 and a cam shaft 2.

[0038] The journal section 42 of a cam shaft 2 is having migration in the direction of a revolving shaft regulated as shown in drawing 1 while being supported pivotable by the bearing 41 prepared in the cylinder head 40. The periphery slots 43 and 44 are established in the hoop direction of the peripheral wall of the journal section 42. A free passage or cutoff is alternatively [as the periphery slots 43 and 44] possible for the supply oil path 47 which feeds the oil in an oil tank 45 with a pump 46, and the discharge oil path 48 which discharges an oil into an oil tank 45 by change actuation of the change bulb 49. A pump 46 and the change bulb 49 constitute an oil pressure driving means. With this operation gestalt, the change bulb 49 is well-known 4 port pilot valve.

[0039] As shown in drawing 3 , the periphery slot 43 is open for free passage with the oilway 30 in the vane rotor 9 in the contact section with the vane rotor 9 with the oilways 37 and 38 in a cam shaft 2. As shown in drawing 1 , the periphery slot 44 is open for free passage to the oilway 36 in the vane rotor 9 in the contact section with the vane rotor 9 with the oilway 39 in a cam shaft 2. While supplying the pressure oil from a pump 46 to the periphery slots 43 and 44 alternatively by the change bulb 49 and attaining supply of the pressure oil from a pump 46 by the above configuration at the lag oil pressure rooms 10 and 11 and the oil pressure room 23, the tooth-lead-angle oil pressure rooms 12 and 13, and the oil pressure room 24, discharge of the oil to an oil tank 45 is attained.

[0040] With constituting minutely the path clearance 16 of the outermost diameter of Vanes 9a and 9b, the die length of the hoop direction of Vanes 9a and 9b has prevented comparatively that the lag oil pressure room 10, the tooth-lead-angle oil pressure room 13 and the lag oil pressure room 11, and the tooth-lead-angle oil pressure room 12 are open for free passage through path clearance 16 as much as possible by the ********. Moreover, the minute path clearance 17 formed in the minimum diameter of Shoes 3a and 3b is equipped with the seal components 6 at 9d of slots of the vane rotor 9, and it has prevented that the lag oil pressure room 10, the tooth-lead-angle oil pressure room 12 and the lag oil pressure room 11, and the tooth-lead-angle oil pressure room 13 are open for free passage through path

clearance 17 as much as possible.

[0041] Moreover, in order that the vane rotor 9 may carry out relative rotation to the shoe housing 3, sliding path clearance is formed between the medial surfaces of the shaft-orientations both-ends side of the vane rotor 9, the shoe housing 3, and the chain sprocket 1. Although there is a possibility that an oil may leak between oil pressure rooms from this sliding path clearance, the sliding path clearance formed in the shaft-orientations both-ends side of the vane rotor 9 can be minutely constituted by making small slightly the shaft-orientations die length of the vane rotor 9 to the shaft-orientations die length of the shoe housing 3.

[0042] Moreover, the oil leak between oil pressure rooms can be prevented as much as possible according to the die length of the hoop direction of Vanes 9a and 9b being comparatively long, that is, the cross sectional area of Vanes 9a and 9b being large. For this reason, since the oil pressure of each oil pressure room can be held to a predetermined value, the relative rotation of the vane rotor 9 to the shoe housing 3 is controllable with high precision. Moreover, since the cross sectional area of Vanes 9a and 9b is large, the stopper piston 7 can be held easily.

[0043] Next, actuation of a valve timing adjusting device is explained.

[0044] The vane rotor 9 is in the maximum lag location to the shoe housing 3 with [as shown in drawing 1 and drawing 2 , when the pressure oil from a pump 46 is not introduced into the oil pressure rooms 23 and 24 yet at the time of engine starting] rotation of a crankshaft, stopper section 9e is in contact with shoe 3a by the lag side, and rotation driving force is transmitted to a cam shaft 2 through the shoe housing 3 from the chain sprocket 1, and the vane rotor 9.

[0045] Moreover, it fits into the stopper hole 20 according to the energization force of a spring 18, the vane rotor 9 and the shoe housing 3 are energized in the rotation direction by this fitting, and point 7c of the stopper piston 7 is firmly restrained so that the taper side of point 7c of the stopper piston 7 may contact the taper side of the stopper hole 20 by the tooth-lead-angle side. Therefore, in case [of an inlet valve and an exhaust valve] either is driven at least, even if forward and negative reversal torque arises in a cam shaft 2, when the vane rotor 9 has the motion by the side of a lag and a tooth lead angle regulated to the shoe housing 3, a relative rotational vibration is not generated and generating of a tap tone is prevented.

[0046] If 49a of the change bulb 49 is chosen and a pressure oil is fed from a pump 46 as shown in drawing 5 , a pressure oil will be introduced into the lag oil pressure rooms 10 and 11 and the oil pressure room 23 through the periphery slot 44 and oilways 39, 36, 29, 31, 32, and 33. The force which the stopper piston 7 receives with the oil pressure of the oil pressure room 23 is committed in the direction which resists the

energization force of a spring 18 and stuffs the stopper piston 7 into the chain sprocket 1 side of the hold hole 8 according to the projected net area difference by the diameter difference of narrow diameter portion 7a of the stopper piston 7, and major diameter 7b.

[0047] Then, since it escapes from point 7c of the stopper piston 7 completely and comes out of it from the stopper hole 20 of a front plate 4, the vane rotor 9 has constraint with the shoe housing 3 canceled. However, since the oil pressure force of the lag oil pressure rooms 10 and 11 acts on the side face of Vanes 9a and 9b, the vane rotor 9 is held in the maximum lag location still shown in drawing 2 to the shoe housing 3. For this reason, generating of the tap tone of the vane rotor 9 and the shoe housing 3 is prevented.

[0048] In addition, the oil which leaked from the lag oil pressure rooms 10 and 11 to the tooth-lead-angle oil pressure rooms 12 and 13 slightly is discharged from 49a of the change bulb 49 through oilways 34, 35, 30, 38, and 37 and the periphery slot 43 to an oil tank 45.

[0049] If 49c of the change bulb 49 is chosen from the condition shown in drawing 5 as which 49a of the change bulb 49 was chosen as shown in drawing 6 , while the pressure oil from a pump 46 will be introduced into the oil pressure room 24 through the tooth-lead-angle oil pressure rooms 12 and 13 and an oilway 25 through the periphery slot 43 and oilways 37, 38, 30, 34, and 35, the lag oil pressure rooms 10 and 11 and the oil pressure room 23 are opened wide to an oil tank 45.

[0050] Although the stopper piston 7 tends to return to the stopper hole 20 with a spring 18 at this time since the oil pressure of the oil pressure room 23 falls in atmospheric pressure mostly, the oil pressure force of the oil pressure room 24 acts on 7d of apical surfaces of the stopper piston 7, and the stopper piston 7 becomes [resisting the energization force of a spring 18 and being pushed into the chain sprocket 1 side of the hold hole 8 with as, and].

[0051] Then, the oil pressure force of the tooth-lead-angle oil pressure rooms 12 and 13 acts on the side face of Vanes 9a and 9b, the vane rotor 9 is rotated in the clockwise rotation of a tooth lead angle, i.e., the direction, to the shoe housing 3, and the valve timing of a cam shaft 2 is brought forward. When the hoop direction location of point 7c of the stopper piston 7 and the stopper hole 20 of a front plate 4 shifts, the stopper piston 7 stops fitting into the stopper hole 20, if the vane rotor 9 rotates to the shoe housing 3.

[0052] Drawing 7 shows the condition that the vane rotor 9 carried out the tooth lead angle most to the shoe housing 3. If 49a of the change bulb 49 is chosen from the condition of drawing 7 , the vane rotor 9 will be seen from [of drawing 1] X to the

shoe housing 3, it will rotate in the counterclockwise rotation of a lag, i.e., the direction, and the valve timing of a cam shaft 2 will be delayed.

[0053] If change bulb 49b is chosen as the vane rotor 9 is rotating in the direction of a tooth lead angle, or the direction of a lag to the shoe housing 3, an inflow and an outflow are intercepted, the vane rotor 9 is held in a middle location, and the oil of the lag oil pressure rooms 10 and 11 and the tooth-lead-angle oil pressure rooms 12 and 13 can obtain desired valve timing. The stopper piston 7 fits into the stopper hole 20 of a front plate 4, and when a pressure oil is introduced, it stops fitting into the stopper hole 20 as mentioned above, when the vane rotor 9 is in the maximum lag location to the shoe housing 3 and the pressure oil is not introduced.

[0054] With the 1st operation gestalt of this invention explained above, a housing member and a vane member can be restrained firmly, aligning a housing member and a vane member on the same axle, since it has the wedge effectiveness by contact of the taper side of the stopper hole 20 and the stopper piston 7 and the direct contact to a housing member and a vane member is strengthened.

[0055] Even if there is a location gap by the manufacture error of the stopper piston 7 and the stopper hole 20, the stopper hole 20 can be made to carry out fitting of the stopper piston 7 certainly, since point 7c of the stopper piston 7 is furthermore made into the shape of a taper and displacement of the stopper piston 7 is enabled at the shaft orientations.

(The 2nd operation gestalt) The 2nd operation gestalt of this invention is shown in drawing 9 and drawing 10 . The 2nd operation gestalt was replaced with the stopper piston 7 as the contact section of the 1st operation gestalt, was replaced with the guide ring 19 using the stopper piston 50, and has held the guide ring 51 in the interior of vane 9a. In addition, the same sign is substantially given to the same component with the 1st operation gestalt.

[0056] The condition to which, as for drawing 9 , the stopper piston 50 fitted into the stopper hole 20 of a front plate 4, and the condition that the pressure oil was introduced into the oil pressure room 23, drawing 10 fell out from the stopper hole 20, and the stopper piston 50 came out of it are shown.

[0057] The stopper piston 50 is constituted by narrow diameter portion 50a, medium diameter portion 50b, and major diameter 50c, and the guide ring 51 is constituted by small bore section 51a and Ochi diameter 51b. It is fixed to the vane rotor 9 by press fit etc., and a guide ring 51 can slide on the stopper piston 50 to a guide ring 51. The annular damper room 52 which is a fluid damper and by which abbreviation sealing was carried out is formed of the peripheral wall of narrow diameter portion 50a of the stopper piston 50, and medium diameter portion 50b, and the inner circle wall of a

guide ring 51.

[0058] As shown in drawing 9 , in the condition that the pressure oil is not supplied to the oil pressure rooms 23 or 24 yet from the pump 46 immediately after engine starting, the vane rotor 9 is in the maximum lag location to the shoe housing 3, and the stopper piston 50 fitted into the stopper hole 20 according to the energization force of a spring 18, and has connected the front plate 4 and the vane rotor 9.

[0059] If 49a of the change bulb 49 is chosen from the condition shown in drawing 9 , a pressure oil will be supplied to the oil pressure room 23, and as shown in drawing 10 , it will slip out of the stopper piston 50 from the stopper hole 20. Drawing 9 and drawing 10 show the condition that the vane rotor 9 is in the maximum lag location to both the shoe housing 3. If a pressure oil is supplied to the oil pressure room 23, the interior of the damper room 52 will be filled up with an oil through the fitting path clearance of the stopper piston 50 and a guide ring 51.

[0060] When 49c of the change bulb 49 tends to be chosen and it is going to rotate the vane rotor 9 in the direction of a tooth lead angle to the shoe housing 3 from the condition shown in drawing 10 , few time lags arise until the oil pressure of the oil pressure room 24 becomes a predetermined value, even if the change bulb 49 changes. Then, it may move in the direction in which the stopper piston 50 fits into the stopper hole 20 according to the energization force of a spring 18. Since small [every] deer discharge of the oil in the damper room 52 is not carried out from fitting path clearance even if the stopper piston 50 tends to move in the direction of fitting with the stopper hole 20, the damper room 52 acts so that the passing speed to the direction of fitting of the stopper piston 50 may be made to ease.

[0061] For this reason, relative rotation control of the vane rotor 9 to the shoe housing 3 by oil pressure can be continued, without the stopper piston 50 fitting into the stopper hole 20, since the oil pressure of the oil pressure room 24 reaches a predetermined value before the stopper piston 50 fits into the stopper hole 20.

[0062] With the 2nd operation gestalt, it can prevent certainly that the stopper piston 50 is stuffed into the stopper hole 20 for a moment in the transition stage which moves in the direction of a tooth lead angle from the condition which has the vane rotor 9 in the maximum lag location to the shoe housing 3.

[0063] Even if it makes the oil pressure room 23 open for free passage with the tooth-lead-angle oil pressure rooms 12 and 13 and makes the oil pressure room 24 open for free passage with the lag oil pressure rooms 10 and 11 in the 1st operation gestalt or the 2nd operation gestalt as other operation gestalten of this invention, the same effectiveness as the 1st operation gestalt or the 2nd operation gestalt can be acquired.

(The 3rd operation gestalt) The 3rd operation gestalt of this invention is shown in drawing 11 and drawing 12 .

[0064] The configuration of those other than the configuration of the stopper hole 60 shown in drawing 11 and drawing 12 is substantially [as the 1st operation gestalt] the same. Drawing 11 shows the fitting condition of the stopper piston 7 and the stopper hole 60 in the direction of a path of a cam shaft, and the peripheral face of the stopper piston 7 and the inner skin of the fitting hole 60 have contacted by the drawing near side.

[0065] As shown in drawing 12 , the cross-section configuration of the stopper hole 60 is formed in the shape of a slot in the vertical direction of a path of drawing 12 , i.e., the direction of a front plate 4. Therefore, the stopper hole 60 as the contacted section is an ellipse in alignment with medial-axis 60c prolonged in the direction of a path, and the inner skin is formed in the shape of [of a taper] a taper. And the peripheral face of point 7c of the stopper piston 7 as the contact section is formed in the circular taper taper-like cross section.

[0066] Furthermore, since it is designed by the location of the stopper piston 7, and the location of the stopper hole 60 like the 1st operation gestalt so that these components of each other may be pushed when the shoe housing 3 and the vane rotor 9 are in the maximum lag location as a restricted location, the shoe housing 3 and the vane rotor 9 are restrained firmly.

[0067] Moreover, since the stopper hole 60 was formed in the direction of a path at the ellipse, when the stopper piston 7 fits into the stopper hole 60, the taper side of both direction of a path contacting, and energizing a front plate 4 in the direction of a path is prevented. It is prevented that the force which inclined toward the sliding section between the front plates 4 and the cylinder lobes 5 which are designing path clearance small as much as possible by this is added, and polarized abrasion is prevented. Similarly, between housing members including a front plate 4, and vane members including the vane rotor 9, it is prevented that the variation rate of the direction of a path arises, and prevention of the seal nature fall between both members is attained as well as the polarized abrasion between both members.

[0068] Thus, with the 3rd operation gestalt, since the stopper hole 60 was made into the ellipse in the direction of a path and contact in the stopper piston 7 and the stopper hole 60 was restricted in the rotation direction of the vane rotor 9 even if it generated the force which restrains a housing member and a vane member firmly, it can prevent that the unnecessary force of the direction of a path acts between a housing member and a vane member. Therefore, a housing member and a vane member can be restrained firmly, aligning a housing member and a vane member on

the same axle.

(The 4th operation gestalt) The 4th operation gestalt of this invention is shown in drawing 13 and drawing 14 . The same sign is substantially given to the same component with the 1st operation gestalt. With the 4th operation gestalt, it replaced with the drain hole 21 prepared in the side attachment wall by the side of the chain sprocket 1 of vane 9a in the 1st operation gestalt, and the atmospheric-air hole 22 prepared in the chain sprocket 1, the drain hole 71 was formed in the peripheral wall of vane 9a, and the atmospheric-air hole 72 is formed in the peripheral wall of the shoe housing 3. When the drain hole 71 and the atmospheric-air hole 72 are open for free passage, a free passage hole is constituted and atmospheric-air disconnection of back pressure room 8a which is the hold hole 8 by the side of the chain sprocket 1 is possible.

[0069] The volume of back pressure room 8a will decrease, if the stopper piston 7 moves in the right of drawing 13 , i.e., the restricted discharge direction of the shoe housing 3 and the vane rotor 9, and if the stopper piston 7 moves in the left of drawing 13 , i.e., the restricted direction of the shoe housing 3 and the vane rotor 9, it will increase.

[0070] As shown in drawing 13 , the vane rotor 9 is in the maximum lag location to the shoe housing 3, and in the condition that the pressure oil is not supplied to the oil pressure rooms 23 and 24, mostly, the stopper piston 7 fits into the stopper hole 20, and it is opening [the hole / the location is in agreement the drain hole 71 and the atmospheric-air hole 72, and] for free passage.

[0071] Since, as for the stopper piston 7, the drain hole 71 is blockaded with the outer wall of ejection and major diameter 7b from the stopper hole 20, back pressure room 8a has a free passage with atmospheric air intercepted as shown in drawing 14 if a pressure oil is supplied to the oil pressure room 23 from the condition shown in drawing 13 . Drawing 13 and drawing 14 show the condition that the vane rotor 9 is in the maximum lag location to both the shoe housing 3.

[0072] When it is going to rotate the vane rotor 9 in the direction of a tooth lead angle to the shoe housing 3 from the condition shown in drawing 14 , few time lags arise until the oil pressure of the oil pressure room 24 becomes a predetermined value, even if the change bulb which is not illustrated changes. Even if it is going to move in the direction in which the stopper piston 7 fits into the stopper hole 20 according to the energization force of a spring 18 at this time, since back pressure room 8a has a free passage with atmospheric air intercepted and is sealed, the passing speed to the direction of fitting of the stopper piston 7 is eased.

[0073] Therefore, the tooth-lead-angle rotation of the vane rotor 9 to the shoe

housing 3 by oil pressure can be started, without the stopper piston 7 fitting into the stopper hole 20, since the oil pressure of the oil pressure room 24 reaches a predetermined value before the stopper piston 7 fits into the stopper hole 20.

[0074] Although both the point of a stopper piston and the stopper hole were formed with the taper side with the above-mentioned operation gestalt of this invention explained above, it is good only also considering these either as a taper side. For example, one side may be made into a taper side and another side may be formed with the spherical surface which can slide on a taper side top. Furthermore, since it is important that there is a slant face in order to generate the energization force of the rotation direction according to the wedge effectiveness, on the other hand, a stopper hole may be formed in the configuration by the side of the rotation direction which has a slant face only for example, in a tooth-lead-angle side at least.

[0075] Moreover, although stopper section 9e was made to contact shoe 3a with the above-mentioned operation gestalt as the maximum lag location is made into a restricted location and shown in drawing 2 , stopper section 9e by the side of the maximum lag may be prepared in the left-hand side of vane 9a of drawing 2 , and shoe 3b may be made to contact. Even in this case, the force which forces the vane rotor 9 on the shoe housing 3 by contact in the tooth-lead-angle side taper-like side face of a stopper piston and a stopper hole can be acquired, and both can be restrained firmly.

[0076] Moreover, although it constituted from an above-mentioned operation gestalt so that it may design so that the vane rotor rotation direction may come out of a stopper piston and a stopper hole on the other hand and it may contact only in the opposite side only by the side of a certain direction of a tooth lead angle (i.e., a restricted location), and the rotation force by the wedge effectiveness might be generated and a housing member and a vane member might be restrained A stopper piston and a stopper hole may contact in both rotation directions, and may restrain a housing member and a vane member by contact of only a stopper piston and a stopper hole. In this case, high intensity is needed for a stopper piston. Moreover, it is desirable to make a stopper hole into an ellipse in the direction of a path, and to limit contact of a taper side only to the rotation direction side face also in this case.

[0077] Moreover, with the above-mentioned operation gestalt, although the cone angle of a stopper piston and the cone angle of a stopper hole were made the same, if fitting in a stopper hole is possible for a stopper piston, it is not necessary to make the same the cone angle of a stopper piston, and the cone angle of a stopper hole.

[0078] Moreover, although the chain sprocket was rotated with the crankshaft which is a driving shaft, shoe housing as a housing member fixed to it was rotated with the crankshaft and the vane rotor was rotated with the above-mentioned operation

gestalt with the cam shaft which is a follower shaft, it is also possible to rotate a chain sprocket with a cam shaft and to rotate a vane rotor with a crankshaft. In this case, a vane rotor is restrained to shoe housing in the maximum tooth-lead-angle location.

[0079] Moreover, with the above-mentioned operation gestalt, two cam shafts, the cam shaft for inhalation-of-air valve-opening close and the cam shaft for exhaust valve closing motion, may infix a valve timing adjusting device between two cam shafts in the engine prepared in parallel. For example, when a cam shaft is used as a driving shaft and while synchronizing with a chain etc. and rotating from a crankshaft sets a follower shaft as the cam shaft of another side with means of communication, such as a gear, it may be made to rotate with a cam shaft and a housing member may be rotated with the cam shaft of another side which is a follower shaft while it is a driving shaft about a vane rotor, and this reverse is sufficient.

[0080] Moreover, although two vanes were prepared in the vane rotor with the above-mentioned operation gestalt, a piece or three pieces or more are sufficient as a vane.

[Brief Description of the Drawings]

[Drawing 1] It is the I-I line sectional view of drawing 2 showing the valve timing adjusting device by the 1st operation gestalt of this invention.

[Drawing 2] It is the cross-sectional view showing the valve timing adjusting device by the 1st operation gestalt of this invention.

[Drawing 3] III-III of drawing 2 It is a line sectional view.

[Drawing 4] It is the IV-IV line sectional view of drawing 2 .

[Drawing 5] It is drawing of longitudinal section showing the condition that the stopper piston of the 1st operation gestalt escaped from and came out from the stopper hole.

[Drawing 6] It is drawing of longitudinal section showing the condition that the vane rotor rotated in the direction of a tooth lead angle, to shoe housing of the 1st operation gestalt.

[Drawing 7] It is the cross-sectional view showing the 1st operation gestalt in the condition of drawing 6 .

[Drawing 8] It is the mimetic diagram showing the hydraulic circuit of the 1st operation gestalt.

[Drawing 9] It is drawing of longitudinal section showing the valve timing adjusting device by the 2nd operation gestalt of this invention.

[Drawing 10] It is drawing of longitudinal section showing the condition that the stopper piston of the 2nd operation gestalt escaped from and came out from the stopper hole.

[Drawing 11] It is the sectional view showing the fitting condition of the stopper piston

of the 3rd operation gestalt, and a stopper hole.

[Drawing 12] XII–XII of drawing 11 It is a line sectional view.

[Drawing 13] It is drawing of longitudinal section showing the valve timing adjusting device by the 4th operation gestalt of this invention.

[Drawing 14] It is drawing of longitudinal section showing the condition that the stopper piston of the 4th operation gestalt escaped from and came out from the stopper hole.

[Description of Notations]

1 Chain Sprocket (Housing Member)

2 Cam Shaft (Follower Shaft)

3 Shoe Housing (Housing Member)

3a, 3b Shoe

4 Front Plate (Housing Member)

7 Stopper Piston (Contact Section)

7c Point

8a Back pressure room

9 Vane Rotor (Vane Member)

9a, 9b Vane

20 Stopper Hole (Contacted Section)

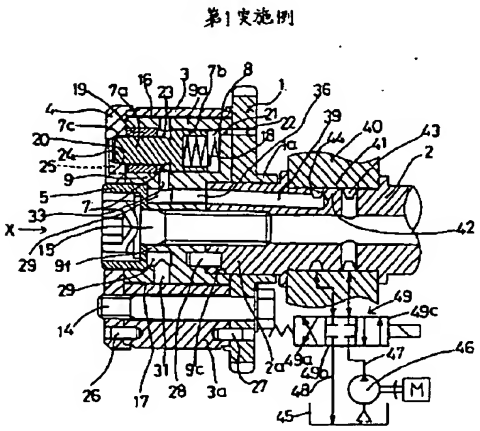
46 Pump (Driving Means)

49 Change Bulb (Driving Means)

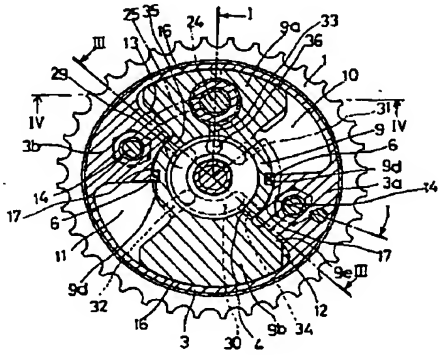
50 Stopper Piston (Contact Section)

60 Stopper Hole (Contacted Section)

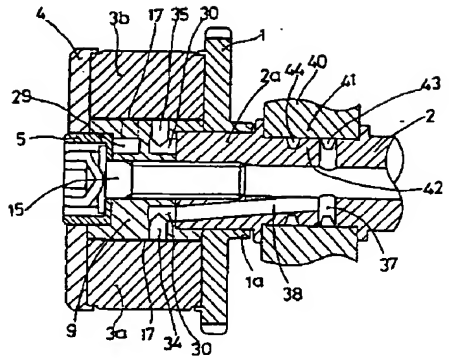
[Drawing 1]



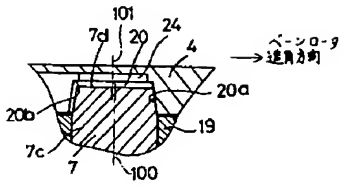
[Drawing 2]



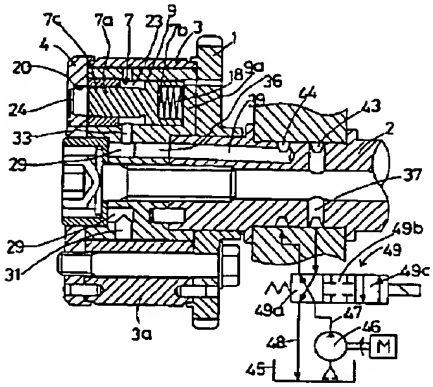
[Drawing 3]



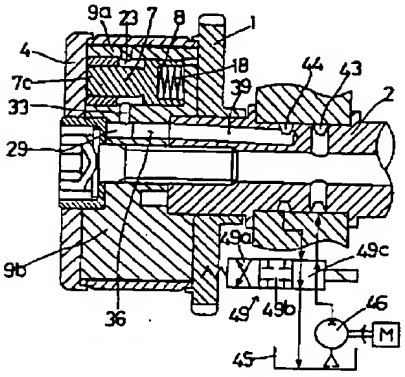
[Drawing 4]



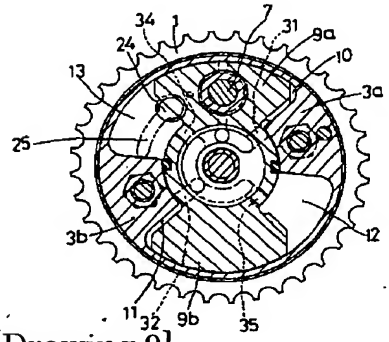
[Drawing 5]



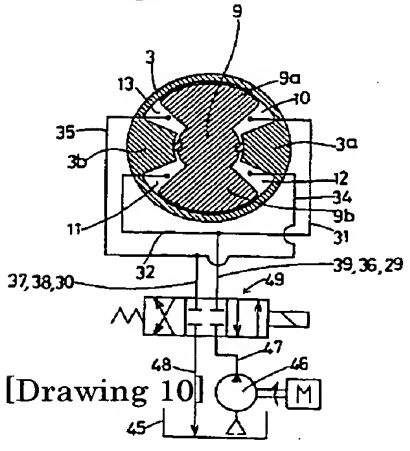
[Drawing 6]



[Drawing 7]

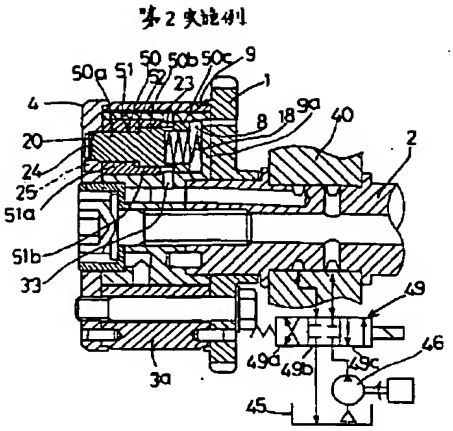


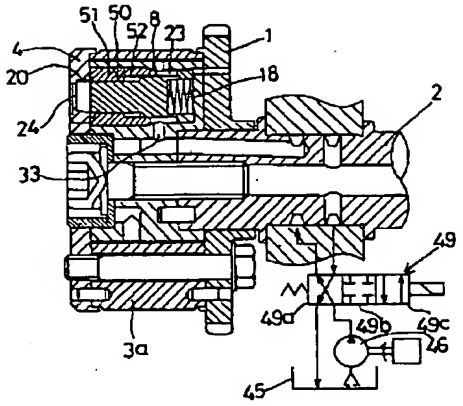
[Drawing 8]



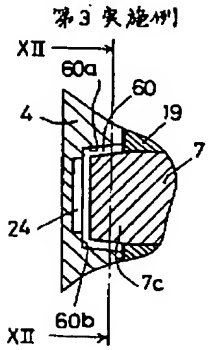
[Drawing 9]

[Drawing 10]

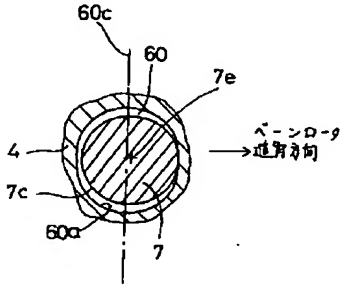




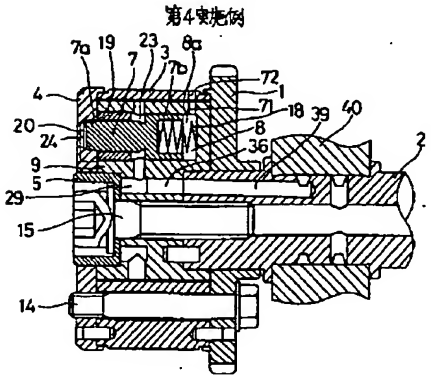
[Drawing 11]



[Drawing 12]



[Drawing 13]



[Drawing 14]